

# National Renewable Energy Laboratory Self-Assessment Report (April 1 – September. 30, 2003)

## Executive Summary

The National Renewable Energy Laboratory, under the stewardship of MRI and its integrated team of Battelle and Bechtel, successfully met or exceeded performance expectations across each Critical Outcome. Highlights include:

- Outstanding science and technology (S&T) accomplishments fully enabled by high quality RD&D
- Exceptional program planning, management and integration
- Effective communication and outreach
- Agile business support and infrastructure management
- Proactive leadership demonstrated across all aspects of the business

In serving the needs of EERE and the nation, NREL proactively and effectively responded to emerging challenges and opportunities while exceeding expectations across its six Critical Outcomes. At the foundation of NREL's progress was strong collaboration and cooperation with EERE and GO.

Based on the results detailed in this Self-Assessment Report, NREL proposes an overall Laboratory performance rating of **Outstanding**.

## CO 1.0 Science and Technology

The Laboratory's continued outstanding track record in producing relevant, high-quality science and technological outcomes is evidenced at both the institution and individual level by:

- NREL's increasing role in providing technical advice and supporting development of integrated, DOE multi-year RD&D plans
- Advances in S&T that support DOE objectives
- Adoption and use of NREL-originated technology and knowledge by others.

NREL and its staff received considerable external recognition for S&T excellence in innovation, relevance and quality of the work, technology transfer, and mentoring. Awards included an R&D 100 award, an Institutional Federal Laboratory Consortium (FLC) Award for NREL's long-term commitment to expanding the use of renewables, and a DOE Outstanding Mentor award. Peer reviews of NREL's work acknowledged its quality and relevance and provided useful feedback on potential future directions. Numerous invitations to speak, lecture, publish, or chair conferences recognized NREL as a valued source of intellectual leadership.

While delivering on program commitments, the Laboratory played an increasingly significant role in DOE multi-year technical plans and integrated FY04 annual operating plan development. The enhanced role of NREL as a technical adviser and strategic partner in planning yielded high-quality technical plans, such as the multi-year RD&D plan for the Hydrogen, Fuel Cell, and Infrastructure Technologies (HFCIT) program that was well received by the National Research Council. The roles that NREL played in supporting DOE planning enabled the strong alignment of NREL efforts with the objectives of those plans. NREL's maturing systems-based analytical capabilities provided value to DOE planning by validating program technical targets, such as the preliminary system and component level targets for heavy hybrid vehicles under the FreedomCAR and Vehicle Technologies Program. In several cases, such as in the Biomass Program, NREL supported DOE by serving as the technical integrator among the laboratories and other program participants to ensure that individual efforts are aligned and support overall program goals.

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*Expectations for innovation, quality, and impact, along with a supportive work environment established by MRI and its integrated management team enables NREL to produce relevant, high-quality S&T outcomes.*

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S&T advances lower costs and/or increase reliability of DOE-supported technologies or reduce barriers to their use. Key S&T accomplishments furthering DOE program goals, were made in every program. Examples include;

- Demonstrating bench-scale production of hydrogen from waste plastic
- Significantly exceeding the cellulose enzymes target cost reduction
- Receiving final approval of the distributed generation interconnection standards
- Validating the efficacy of energy-efficient liquid desiccant technology to deactivate anthrax spores using MRI's certified biosafety laboratories
- Increasing solar cell efficiencies
- Advancing the understanding of nocturnal low-level jet streams in order to understand the potential impact on low wind speed turbine designs

NREL technical assistance enabled the federal government to increase its use of renewables to more than 50% of its 2005 goal by yearend through the Federal Energy Management Program. The Laboratory formed three strategic industrial partnerships under the Biomass program that will advance program goals and transfer NREL-originated intellectual property for commercial use. The National Alliance of Clean Energy Business Incubators now supports 80 companies that have created nearly 1,000 jobs. The growing recognition of NREL as a player in the technology transfer community was acknowledged by the FLC award mentioned earlier, and by its growing impact within the DOE Technology Partnerships Working Group. Additionally, NREL took the lead in developing an intellectual property framework that enabled partnering in a proposed virtual hydrogen storage center among seven universities, three federal laboratories, and an industrial company.

Based on its continued record of innovation, quality, and impact, NREL proposes a rating of **Outstanding** for the Science and Technology Critical Outcome.

## CO 2.0 Leadership

By advancing new concepts, providing fresh insight through analyses, and by providing expert knowledge in key forums, NREL has influenced the direction of DOE program strategies and national policy and programs.

Laboratory leadership and corporate support defined and launched the systems integration role for the DOE Hydrogen Program. Working closely with DOE, NREL laid the groundwork to establish the capability and began development of an integrated baseline. The search for a Systems Integration director has yielded several quality candidates and NREL expects to have the director in place in the first quarter of FY04. Development of the first Systems Integration plan enabled positive interactions with key external stakeholders, such as the National Research Council and the FreedomCAR and Fuel Partnership.

NREL leadership in strategic analyses provided a basis for exploring the feasibility of new initiatives, such as a potential solar initiative, and for making program and policy decisions. Multiple analyses conducted for the HFCIT and FreedomCAR and Vehicle Technologies programs led to fuel cell and hydrogen storage target revisions, and illuminated the fuel consumption penalty associated with cold starts on reformed gasoline fuel cell vehicles that will inform the 2004 go/no go decision. NREL analysis also informed stakeholder choices among technology options. Through NREL's air quality initiative, analyses are informing EPA, state and local environmental policy and program decisions, and analyses of the solar resource and use of NREL-developed system analysis tools have supported SolarGenix in developing a proposed 50MW<sub>e</sub> CSP plant to generate enough electricity in 2005 - 2006 to comply with the solar portion of the Nevada renewable energy portfolio standard.

NREL provided technical leadership in defining a diverse set of new opportunities and future directions. The Lab catalyzed and co-wrote a multi-laboratory white paper that proposes how to integrate and use the technical resources of the national laboratories to advance the goals of the Solid State Lighting initiative. NREL led development of a vehicle power electronics roadmap

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*MRI and its integrated team continued to steward knowledge and technology from creation through its transfer to others via a record number of publications, technical assistance to domestic government agencies and international organizations, and through a variety of partnerships with the commercial sector.*

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*MRI and its integrated team of Battelle and Bechtel provide leadership to strengthen NREL's role as a Federally Funded Research and Development Center (FFRDC) - supporting the EERE mission.*

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that will serve as a guide for future multi-year RD&D plans. NREL worked with the regional offices and with other labs to develop a collaborative state technical assistance program to be delivered through regional offices, and worked with DOE, other agencies, and NGOs to develop an African clean energy initiative.

By convening or providing leadership in key forums, NREL had an influence in establishing national directions in key areas that advanced EERE program objectives. An NREL-organized summit led to the blueprint development for domestic hydrogen codes and standards; a joint meeting between the Wind and Hydropower and the HFCIT programs, including industry and key stakeholders, created an understanding of opportunities and demonstrated the program commitment to including these resources in its long-term plans; and NREL technical leadership in multiple International Energy Agency agreements on behalf of DOE programs continued to favorably position the United States as a leader in key areas such as hydrogen and renewable energy.

NREL led the development and implementation of multiple strategic partnerships that leverage resources and advance DOE program priorities. Included among these was the development of a strong team to implement a proposed virtual Carbon-based Hydrogen Storage Center. The significant number of white papers submitted by potential participants is an indicator of the strong interest in teaming under NREL's leadership in this center. The award of a major Office of Science nanoscience project to NREL provides resources in an area of science that will underpin future advances in photovoltaics. The selection of this proposal through a competitive, peer-reviewed process is an indicator of NREL's technical leadership in nanoscience. The development of a five-year CRADA valued at \$7M, with AVL, licensee for the ADVISOR™ model, will improve the capabilities of the model and extend its value to DOE and other users.

A rating of **Outstanding** for Critical Outcome 2.0 Leadership is proposed, based on the broad and diverse examples of NREL's leadership in creating new opportunities and partnerships, and in influencing program and policy directions through its technical and analytical expertise.

### CO 3.0 Technical and Scientific Viability

NREL continued to enhance its technical capabilities (research staffing, facilities, and equipment) in support of long-term program needs, national energy goals and national environmental sustainability goals through focused investments.

NREL's strategic focus was demonstrated by the completion of the 25-year NREL General Development Vision. Developed with creative NREL leadership supported by a team of nationally recognized architects, including support from Bechtel and collaboration with DOE, this plan provides a framework for developing both the South Table Mountain Site and National Wind Technology Center. Building on the current physical infrastructure, and responding to the many land use challenges presented by NREL's two sites, this effort envisions the development of its very compact campus during the next 25 years to support excellence in state-of-the-art R&D; safe, healthy, efficient, and secure operations; the best principles of sustainable site development; NREL's image of excellence in R&D and sustainability; and positive relations with close neighbors. This vision will guide strategic physical investments at NREL.

NREL worked closely with GO in diligent efforts to develop NREL's next major research building, the Science & Technology Facility (S&TF). The S&TF will provide the United States with a unique capability to develop advanced technologies for thin-film and nanostructure fabrication in support of renewable energy and energy efficiency goals.

Recognizing the movement of wind turbine technology toward larger turbines for lower wind speeds, NREL developed plans for critically needed new facilities at the National Wind Technology Center. The current dynamometer and blade testing facilities will continue to support many areas of developing technology, but cannot be expanded to meet the new, larger

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*MRI and its integrated team of Battelle and Bechtel demonstrate commitment to long-term viability of NREL as a unique national asset that will provide ever-increasing value to the nation.*

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requirements. NREL's strategic discussions with industrial stakeholders and DOE led to development of initial documentation for DOE management review.

Upgrading and expanding research equipment is another key component in maintaining Laboratory long-term viability. Engendering program support and strategically selected investments, NREL continues to strengthen its long-term capabilities. For example:

- Capabilities in computational science continue to be developed as a fundamental tool for improving productivity and creativity in all areas of research, introducing nearly fifty NREL staff to the opportunities offered by computational science at an internal workshop featuring speakers from DOE.
- A computational chemistry capability was added that will help advance several research areas at NREL.
- Analytical equipment was purchased to begin establishing a new capability to examine the surfaces of biological materials and samples, supporting research in biomass, hydrogen and related areas.
- A clean room and additional analytical equipment were added to expand capabilities in hydrocarbon emissions from fuels.
- X-ray diffraction equipment and a transmission electron microscope were purchased to advance the state-of-the-art of hydrogen fuel cell research, and solar and general solid-state materials research.
- Distributed energy and electric reliability testing equipment was expanded to examine the response of systems to abnormal utility conditions.

The long-term viability of the Laboratory also depends on nurturing new scientific ideas that could lead to significant breakthroughs in support of the DOE mission. As examples, NREL researchers established the capability to analyze X-ray diffraction analyses of single crystals, which will provide new insights for photovoltaic, solid-state lighting, carbon nanotube, and other technologies dependent on solid-state materials. In another area, NREL is developing a new capability to characterize the energy levels of individual nanoparticles, which will yield insights into how best to synthesize and use these new materials in next-generation solar cells, carbon-based hydrogen storage systems, new catalysts, and other materials.

Based on its strategic development of new facilities, infrastructure, and emerging scientific ideas to support the long-term viability of the Laboratory, NREL proposes a rating of **Outstanding** for the Technical and Scientific Viability Critical Outcome.

#### CO 4.0 Mission Support

NREL successfully mitigated negative impacts from late receipt of funding and pension fund pressures that resulted in a stable labor multiplier, timely subcontract awards, and effective GSO management in addition to meeting program AOP commitments. Focus on the factors that support strategic management of human capital resulted in enhanced benefits without increased cost, improved performance management processes, and greater flexibility in how staff accomplish work. NREL stewardship of critical IT, facility and security infrastructure assures the appropriate use and protection of DOE assets and investments. At the same time, NREL continues to be a leader in "walking the talk" in energy efficiency and renewable energy.

Through effective design and construction project management, stakeholder outreach, and close collaboration with GO, a critical milestone was met in gaining approval from DOE for S&TF Critical Decision 2, authorizing NREL to complete final design documents for the S&TF before the allocation of construction funds. The DOE Office of Engineering and Construction Management noted that the project both supported the DOE mission and used a design process that ensured that functional requirements were clearly identified and users were heavily involved.

NREL's performance measurement system continues to evolve, providing useful and timely information about where to focus improvements. Process metric trends and staff survey results

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*MRI and its integrated team of Battelle and Bechtel ensure that NREL remains vital by guiding investments that build capabilities for current and future mission needs while protecting and enhancing existing capabilities.*

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*MRI and its integrated management team's leadership and commitment to continuous improvement in business and operational systems and processes help NREL meet or exceed business and operating performance expectations.*

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support management decision-making and driving productivity gains. For example, the Foreign Travel closeout process, identified as an area needing attention during the first performance period was enhanced with the result of a significant reduction in the number of outstanding closeouts. Other efficiency gains included increased subcontract closeouts and improved efficiency in cost/price analysis and subcontract auditing.

The Lab gained increased external recognition of its improvement efforts as illustrated by the LOB recently identifying NREL's performance-based management approach and its requirement management system as best practices.

Based on its continued record of providing exceptional mission support that enables the S&T mission, NREL proposes a rating of **Outstanding** for the Mission Support Critical Outcome.

## **CO 5.0 Environment, Safety, and Health**

NREL's commitment to strong ES&H performance met or exceeded benchmark standards and targets, and incorporated process improvements while providing efficient delivery of support services.

Laboratory performance against ES&H benchmark standards continues to be best in class, in comparison to both DOE and private industry. ES&H standards and metrics were further refined to better identify and focus on areas most important to the Laboratory's mission. Coordination with other DOE national laboratories maximized sharing of lessons learned, established more accurate external baselines, and communicated NREL's successes across the DOE complex. Additionally, the Laboratory effectively responded to, and corrected, all factors associated with the potential fire safety issue reported in the previous period, ensuring that all factors were corrected. Lessons learned from this effort resulted in implementation of several best-management practices, which were communicated throughout the DOE complex. Through a cooperative GO/NREL effort, quarterly ES&H briefings are conducted for EERE executive management, allowing them to better understand and communicate how NREL's ES&H performance supports the EERE mission.

The South Table Mountain Site-wide EA was completed under budget, even after the inclusion of two supplemental field studies not included in the original EA scope. Process improvements also resulted in a document that is a more effective planning and management tool than previous EA's, and that is fully coordinated and integrated with other planning documents, such as NREL's 25-year General Development Vision. EA's also were completed in support of several significant off-site projects. These activities support the EERE mission by making full use of increased environmental expertise developed within the Laboratory over the past year.

The Laboratory took significant steps toward gaining formal recognition of its environmental management system. The Laboratory's leadership in areas such as management of workplace injuries, sustainability and environmental management resulted in NREL and DOE-GO staff jointly presenting these success stories through various external forums. Again in coordination with DOE-GO, the Laboratory has pursued integration of its ES&H systems with those of a major EERE program.

A rating of **Outstanding** for Critical Outcome 5.0, Environmental, Safety and Health is proposed, based on performance results, process improvements, and support of the EERE mission both within and external to the Laboratory.

## **6.0 Outreach and Stakeholder Relations**

NREL's performance in outreach and stakeholder relations was exceptional. The Lab's media outreach strategy delivered striking results in terms of national visibility for DOE and NREL, especially as evidenced by the unprecedented media coverage of DOE's American Solar Challenge. Two key goals – increasing awareness of the DOE and NREL missions, and gaining significant visibility for DOE and the Laboratory along Colorado's Front Range – met with

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*MRI and its integrated team of Battelle and Bechtel ensures that NREL's culture embraces and practices concepts of integrated safety management, and supports strong ES&H results.*

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extraordinary results. Initiatives to build working relationships with key media and public policy stakeholders continued to show significant results, with several national leaders praising the Laboratory's research and staff in public appearances. National visibility for DOE and NREL also grew dramatically as the Laboratory built new, and nurtured existing, relationships with leading journalists and capitalized on national "issues in the news" to gain recognition for energy efficiency and renewable energy technologies. The growing success of NREL's Colorado Executive Outreach (CEO) program brought new business and government leaders to the Laboratory to build networks and key alliances. This performance period was marked by major successes in introducing DOE and NREL to new local stakeholders and in seeing an unparalleled number of visitors to the Laboratory. A community leaders breakfast at the National Wind Technology Center, and an aggressive strategy to offer special events and better programming at the Visitors Center – such as the 2-day Consumer Energy Expo – attracted a record number of visitors to NREL.

NREL's leading-edge communications technologies were pivotal in providing technical expertise and efficient high-quality communications products for the Laboratory's researchers and their programs. For example, NREL's extensive knowledge of solar and hydrogen technologies and industries helped these programs more clearly present and articulate their ideas, increasing the effectiveness of these plans.

NREL's education programs benefited from programmatic growth, strategic partnerships and enhanced outreach, positioning NREL and DOE to take advantage of even greater opportunities in FY04. Increased EERE and NREL national visibility in the science education community is a positive outcome of leveraging significant external investments in the Laboratory's education programs. A substantial BP America partnership with NREL has produced a Renewable Energy and Efficiency Education outreach vehicle providing a showcase of DOE/NREL research and technology for new, broader audiences. In recognition of the Laboratory's excellence in education program management, partners joined forces with NREL to deliver education outreach to greater numbers of students and educators than ever before. New fuel cell and hydrogen education workshops highlighted a continually evolving NREL/Colorado School of Mines collaboration reaching over 200 local and national middle school students and teachers. As a result of the exceptional program execution of the 2003 DOE National Middle School Science Bowl, DOE's Office of Science awarded NREL leadership of the 2004 National Middle School Science Bowl. This new responsibility will allow DOE and NREL to reach greater and more diverse audiences, and providing yet another opportunity to take the renewable energy and energy efficiency message across the nation.

A rating of **Outstanding** for Critical Outcome 6.0, Outreach and Stakeholder Relations is proposed, based on the exceptional results of NREL's outreach and communications.

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*MRI and its integrated management team support NREL's outreach communication and education strategies that deliver exceptional results.*

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